Office of Oversight
Environment, Safety and Health

Independent Investigation of the

Portsmouth Gaseous Diffusion Plant

Volume 1: Past Environment, Safety, and Health Practices

May 2000

OVERSIGHT

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Abbreviations Used in This Report

ALARA	As Low As Reasonably Achievable
AEC	Atomic Energy Commission
ALARA	As Low As Reasonably Achievable
ANSI	American National Standards Institute
CFR	Code of Federal Regulations
CIP	Cascade Improvement Program
CPT	Cone Penetrometer Test
CUP	Cascade Uprating Program
DAC	Derived Air Concentration
DCG	Derived Concentration Guide
DMSA	DOE Material Storage Area
DOE	U.S. Department of Energy
D&D	Decontamination and Decommissioning
EH	Office of Environment, Safety and Health
EMP	Environmental Monitoring Plan
EPA	Environmental Protection Agency
ERDA	Energy Research and Development Administration
ES&H	Environment, Safety, and Health
GAO	Government Accounting Office
HF	Hydrogen Fluoride or Hydrofluoric Acid
ISMS	Integrated Safety Management System
JHA	Job Hazard Analysis
LDB	Legionnaire's Disease Bacteria
LLW	Low-level Waste
MCL	Maximum Contaminant Level
MDA	Minimum Detectable Activity
MSDS	Material Safety Data Sheet
NCRP	National Committee on Radiation Protection and Measurement
NESHAPS	National Emission Standards for Hazardous Air Pollutants
NIOSH	National Institute of Occupational Safety and Health
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
OCAW	Oil, Chemical, and Atomic Workers (Union)
OR	Oak Ridge Operations Office
OSHA	Occupational Safety and Health Administration
PAL	Plant Allowable Limit
PCB	Polychlorinated Biphenyl
PORTS	Portsmouth Gaseous Diffusion Plant
P/QA	Performance and Quality Assurance (Department)
RCG	Recommended Concentration Guide
RCRA	Resource Conservation and Recovery Act
RCW	Recirculating Cooling Water
RFI	RCRA Feasibility Investigation
RPG	Radiation Protection Guide
RWP	Radiation Work Permit
SAR	Safety Analysis Report
SOMC	Southern Ohio Medical Center
TCE	Trichloroethene
TLD	Thermoluminescent Dosimeter
TSCA	Toxic Substances Control Act
TSR	Technical Safety Requirement
UF6	Uranium Hexafluoride
UNH	Uranyl Nitrate Hexahydrate
UPGWA	United Plant Guard Workers of America
USEC	United States Enrichment Corporation
USQ	Unreviewed Safety Question
VOC	Volatile Organic Compound

Executive Summary - Historical ES&H Practices

EVALUATION:	Office of Oversight Investigation
SITE:	Portsmouth Gaseous Diffusion Plant
DATES:	January-May 2000

Background/Scope

The Department of Energy (DOE) Office of Oversight, within the Office of Environment, Safety and Health (EH), conducted an investigation of the Portsmouth Gaseous Diffusion Plant (PORTS or Plant) from January through May 2000. This investigation was performed at the direction of the Secretary of Energy, who instructed EH to examine concerns about past operations and work practices, and current management of legacy materials at PORTS. The purposes of this investigation were to: (1) determine whether past environment, safety, and health (ES&H) activities and controls associated with uranium enrichment and supporting operations were in accordance with the knowledge, standards, and local requirements applicable at the time; (2) identify any additional ES&H concerns that had not been documented; and (3) determine whether current work practices for DOE-controlled areas of the site adequately protect workers, the public, and the environment.

Specific areas examined by the EH investigation team included past operations of the Plant, including operation of the cascades and the oxide conversion and feed manufacturing plants; historical and current maintenance and modification programs; worker health and safety programs and practices; historical and current programs and practices for the treatment, storage, and disposal of legacy and newly generated waste; and site remediation. The team also attempted to identify any evidence of potentially hazardous work that PORTS might have performed for others or that was directly related to weapons systems. This investigation examined programs and activities of various organizations responsible for ensuring protection of the workers, the public, and the environment at PORTS, including the Goodyear Atomic Corporation and subsequent management and operating contractors, DOE Headquarters offices, the DOE Oak Ridge Operations Office (OR), Portsmouth Site Office, Bechtel Jacobs, and key subcontractors. This investigation did not evaluate current Nuclear Regulatory Commission (NRC)-regulated United States Enrichment Corporation (USEC) activities, except at interfaces with DOE-controlled areas and activities.

The team interviewed former and current employees; observed work; performed walkdowns of facilities, work areas, and site grounds; conducted environmental sampling and analysis; conducted radiological surveys; and reviewed documents. Interviews were conducted with over 300 current and former employees, including DOE Headquarters, OR, and Portsmouth Site Office personnel; Bechtel Jacobs and subcontractor managers, supervisors, and workers; selected USEC personnel; and stakeholders. The team conducted facility and work area walkthroughs examining Plant operations, work practices, and hazard controls. The investigation team visited essentially all DOE-controlled Plant facilities, waste and material storage areas, and site grounds. The team collected environmental samples from groundwater wells, surface water sources, and sediments both inside and outside the perimeter security fence. The investigation team also reviewed thousands of current and historical documents, including plans, procedures, operations logs, assessments, analyses, and memoranda.

The intent of this investigation was to identify and address the overall ES&H concerns and questions of current and former workers and the public, not to determine the validity of specific allegations. Several ongoing or proposed EH initiatives should provide greater understanding of certain aspects of these issues, including a mass balance project, a medical surveillance project, and an exposure assessment project. This volume, Volume 1, addresses past ES&H activities and practices and their effectiveness in protecting

workers, the public, and the environment. The second volume, Volume 2, deals with current ES&H issues in DOE-controlled areas.

Results

External conditions and influences have had a significant effect on the ES&H-related behavior and intentions of both management and workers at PORTS, especially during the first two decades of operation. When PORTS began production activities, World War II and the Korean conflict had recently ended, and the Cold War was a reality. The work being done was classified, involved high technology, and was important to the national defense. The "need to know" was an ingrained security policy that had a major effect on attitudes toward sensitive operations and materials. The Plant was one of the biggest employers in the area, paying wages significantly higher than available elsewhere locally. Work at PORTS was an attractive alternative to other agricultural or industrial employment options to people in the surrounding region. Management and the Atomic Energy Commission (AEC) were under pressure to maximize production. While most of the hundreds of workers interviewed by the team indicated, in response to specific questioning, that they were unafraid to ask questions about safety and they had no fear of reprisals, a few interviewees did express concerns about both. Industries of the 1950s, including AEC facilities, were largely self-regulated, and guidance and regulatory requirements were evolving. Significant industrial and environmental legislation that would focus attention and actions toward greater protection of workers and the environment was not enacted until the 1970s. Ensuring worker protection was a key part of the Oil, Chemical, and Atomic Workers Union (OCAW) activities since the union's inception in 1954.

Operations and Maintenance

Many operations and maintenance activities at PORTS involved hazardous conditions and the potential for exposure of personnel to physical, radioactive, and chemical hazards. Enrichment process facilities with the potential for such exposures included the cascade and other process buildings; a feed manufacturing plant; an oxide conversion plant; decontamination, cleaning, and uranium recovery facilities; a smelter; and incinerators. Conditions in many work areas were extremely hot, dusty, and noisy. Leaks and off-gassing from process equipment or components being repaired or replaced exposed workers to airborne uranium, transuranics, fission products, fluorine, and hydrogen fluoride (HF) gas. Others worked with, or were exposed to, various hazardous materials and chemicals such as asbestos, trichloroethene (TCE) and other solvents, polychlorinated biphenyls (PCBs), acids, chromium, nickel, lithium, welding fumes and gases, and mercury. Radioactive or hazardous materials were spilled or released to the environment from production related facilities and attendant work activities.

Probably the most hazardous operations at PORTS involved the operation of the oxide conversion plant, which had continuous airborne and surface radioactive contamination problems over its 21-year lifetime, from 1957 to 1978. Personnel working in this facility were exposed to transuranics from recycled reactor fuel feed and to insoluble airborne uranium oxides. Several workers, later put on permanent restriction from working in airborne-contamination areas, received significant intakes that were still detectable in their lungs decades later. Maintenance and modification activities that required breaching process systems or components also exposed workers to radioactive uranium hexafluoride (UF_6) process gas and HF. Decontamination activities in X-705 (Decontamination and Cleaning Building) and elsewhere involved exposures to hazardous solvents and generated the largest amount of radioactive and hazardous liquid waste on site. Personnel performing instrument calibration and trap cleaning were frequently exposed to mercury. Welders were exposed to asbestos fibers and noxious fumes from welding on nickel compounds and Freon piping. PCB-contaminated oils posed long-term personnel exposure hazards.

Hundreds of UF_6 releases occurred from equipment failures and during maintenance, sampling, cylinder handling, and connection and disconnection of feed and product cylinders. These releases caused many intakes of uranium and HF burns, and they contaminated work areas and the environment. Personal protective equipment was usually available, often recommended by industrial hygiene and health physics personnel, or specified in procedures. However, compliance by workers and enforcement by supervision was very inconsistent. Lack of understanding or acceptance of the consequences of non-compliance, insufficient oversight by supervision, and discomfort associated with respirators and extra clothing all contributed to this inconsistency.

The investigation team did not identify any evidence that PORTS performed any work for others that directly involved work with or burial of nuclear weapons components. With the exception of the burial of a dismantled, DOE nickel fabrication plant in the classified landfill in 1979, no evidence was found that PORTS performed any work for others involving hazardous materials. Incidental use of beryllium was identified, including the disposal of sealed plutonium/beryllium sources, use of welding rods, use of early fluorescent bulbs with a beryllium coating, use of tools fabricated from beryllium, and machining of piping components containing beryllium. Several interviews with former workers indicated that there might have been beryllium bar stock on site and in the machine shop, although no specific evidence of that was discovered. Concentrations of beryllium above background levels have been identified in a number of environmental samples taken in the late 1980s and early 1990s from various Plant locations.

Worker Safety and Health Programs

Worker safety and health programs were established when the Plant started operation and have evolved significantly. The implementation and effectiveness of these programs varied widely and, in many ways, failed to adequately protect the safety and health of PORTS workers. Overall, however, occupational illness and injury statistics consistently reflected a much better record than industry averages for comparable manufacturing work settings.

Safety and health training methods and effectiveness also varied greatly. Initial training of operations and maintenance workers was extensive and involved the basics of radiation and industrial safety. However, the rigor of training efforts diminished quickly and, until the 1980s, on-the-job training from supervisors and more experienced workers was standard practice. Monthly safety meetings, posters, newsletters and bulletins, and safety handbooks supplemented the on-the-job training. These materials provided good information on health and safety fundamentals, including radiation protection and the use of personal protective equipment, as well as basic industrial safety information. It was not until the 1990s that a more focused and rigorous ES&H training program was established.

Protection of the safety and health of workers was a line management responsibility, and hazard identification and controls were primarily contained in work procedures and work permits developed by line organizations. Industrial safety, industrial hygiene, and health physics staff performed surveys, inspections, and event analysis and made recommendations for hazard controls and personnel protective actions. However, they had little oversight or enforcement authority until the 1970s. Staffing for all safety and health organizations was very limited well into the 1970s and was insufficient to provide adequate attention for up to 2500 employees working in numerous and varied hazardous conditions. Organizationally, these safety and health groups were located in the Industrial Relations Department and had little direct visibility and access to senior management. When Occupational Safety and Health Administration regulations were issued in the 1970s, the industrial safety group became more proactive and performed comprehensive compliance inspections.

Radioactive contamination and control limits were established to minimize personnel exposures and prevent exceeding regulatory limits. A network of stationary air samplers and portable and breathing zone samplers provided data on airborne contamination. This monitoring frequently showed that limits had been exceeded. PORTS' assumption that all uranium intakes were soluble compounds that would be excreted quickly and could be monitored effectively by urinalysis was not conservative for some locations and activities where insoluble aerosols were generated, such as in the oxide conversion plant and from maintenance activities involving grinding, cutting, and buffing. Respirator use was encouraged and recommended for high-risk operations and activities, but event investigations, safety and health staff inspections, and appraisals by OR identified frequent and continuing non-compliance with respirator requirements. As a result of OR appraisal findings in mid-1972, the site instituted several major program improvements, including issuing new procedures, surveying work areas, procuring additional respirators, training workers, and implementing a respirator fit testing program.

The exposure of workers to radioactive materials was monitored, and with some exceptions, documented exposures were within the limits applicable at the time. However, monitoring deficiencies caused exposures to airborne radioactivity to be underestimated, and actual exposures were likely higher than indicated by PORTS monitoring records. Extremity monitoring was not employed; exposures of hands, feet, and eyes in high beta radiation fields were underestimated and

could have resulted in exposures exceeding limits. A bioassay (urinalysis) program monitored internal uranium exposures and provided a means of verifying and monitoring excretion rates to limit overexposures and identify otherwise unmonitored intakes from releases or airborne contamination at work locations. In 1965, an in-vivo body counting program was initiated to monitor for insoluble enriched uranium, a material for which the urinalysis program was not sufficiently sensitive or reliable. Studies performed in 1990 indicated that the in-vivo counter's capability for analyzing transuranics was questionable, making it difficult to demonstrate that all internal exposures have been accurately detected and assessed.

Goodyear Atomic Corporation established and operated a robust and sophisticated occupational health program in the 1950s and 1960s that provided comprehensive medical examinations and maintained records for accidents and injuries, bioassay programs, and workers compensation cases. In the 1970s and 1980s, the performance of the occupational medicine program declined, as it experienced staffing difficulties and quality-of-care complaints. Under Martin Marietta Utility Services the program was strengthened in the early 1990s, with new procedures and added staffing.

Environmental Management

Over the operating lifetime of the Plant, activities to manage wastes and liquid and air process effluents evolved in response to internal and external requirements. PORTS personnel monitored emerging regulations and established plans and strategies in response to new requirements. However, implementation of necessary changes and new compliance programs often required an extended period of time and was not always fully effective.

General guidelines for handling, storing, and disposing of waste existed in the early days of Plant operations. Throughout the Plant's history, efforts were made to minimize the loss of valuable enriched uranium in Plant waste streams. However, onsite sanitary landfills likely received some contaminated material, since waste segregation practices were not fully understood or effective. As new requirements were enacted, additional waste streams, such as hazardous wastes, were restricted from disposal in onsite landfills. Oils contaminated with PCBs and uranium were spread on roads, disposed of in oil biodegradation plots, burned in open containers, and incinerated.

The State of Ohio mandated closure of important site landfills and the incinerator in the late 1980s and early 1990s, because of concerns over continued disposal of regulated wastes. The Plant ceased offsite shipment of radioactive waste, and without approved commercial treatment and disposal facilities, large amounts of radioactive waste, mixed hazardous and radioactive waste, and radioactively contaminated PCB waste accumulated and were stored on site; much of this waste remains in storage today. Numerous inspections and appraisals by the State of Ohio Environmental Protection Agency (EPA), DOE (e.g., Tiger Team assessment), OR, and internal organizations identified performance problems in the treatment, storage, and disposal of hazardous waste. By 1988, the State of Ohio EPA sent DOE and the Plant a notice of intent to file suit for hazardous waste violations.

In the 1950s, Goodyear Atomic Corporation management was aware that contaminated surplus materials could only be shipped to properly licensed and authorized recipients and that radiological monitoring was required for all potentially contaminated materials being offered for public sale. Although significant efforts were taken to properly segregate clean and contaminated materials intended for sale to the public, there were continued segregation compliance problems and limited health physics manpower to perform surveys of sale materials, indicating a possibility that material exceeding radiological release guidelines was released from the site from the 1950s through the 1980s.

The environmental monitoring program at PORTS was initiated in 1955. In the 1970s, several new wastewater treatment systems were constructed to meet new permit requirements and to significantly reduce the levels of radionuclide emissions. The PORTS National Pollutant Discharge Elimination System permit, issued by the State of Ohio in the 1970s, required testing and reporting of specific chemical and physical properties and set limits on Plant chemical discharges. Radiological discharges have always been subject to the regulations of the AEC and its successors. Despite the discharge restrictions, legacy environmental contamination exists in ponds, local ditches, and streams.

Although Plant management was aware since the 1960s that transuranics and fission products had been introduced into Plant facilities as early as 1957, until 1975 radiological effluent monitoring was only conducted for uranium isotopes and related indicator

parameters. In 1975, technetium, and subsequently transuranic contamination, was unexpectedly discovered in liquid effluents from X-705. Technetium was also detected in airborne discharges. This discovery triggered significant long-term efforts by Plant personnel to isolate sources of technetium and transuranic contamination, develop or improve control methods, and establish appropriate monitoring protocols.

Since the Plant's inception, PORTS was proactive in tracking, assessing, and documenting the potential public dose impact from releases of fluorine or UF_6 to the environment. Dose estimates and release summaries are provided in annual reports starting from the early 1970s in response to AEC requirements. While it is likely that PORTS air emission estimates were done in good faith, these estimates did not reflect all the potential historical releases, including some that could have been significant, such as cell jetting. Evidence of contamination on roofs and grounds and recurring high workplace air sample results in various locations, such as the oxide conversion facility, point to significant unmonitored releases that had not been previously included in monitoring results. The Plant did not perform continuous vent monitoring of radionuclides or fluorides until the mid-1980s, and previous methods for estimating releases have been shown to be unreliable and in some cases non-conservative.

Fluorine and fluoride compounds were used in significant quantities at PORTS and both by design and by accident were vented to the atmosphere. Plant personnel have repeatedly complained of offensive fluorine fumes, breathing difficulty, and respiratory tract damage from releases at the fluorine generating facility and process buildings. The PORTS medical department rarely confirmed significant health effects, but confirmatory surveys to establish release concentrations provided unreliable results due to the rapid dissipation of released gases. Continuous environmental monitoring for fluorides has been conducted for many years, and ambient samplers sometimes indicated fluoride concentrations that exceeded release limits.

Management, Oversight, and Industrial Relations

The AEC, the Environmental Research and Development Administration (ERDA), and DOE have always had a site presence at PORTS, but until 1989 had limited ES&H oversight capability or responsibility. OR conducted very cursory annual safety and health program appraisals from 1957 to at least 1980. However, these appraisals typically involved two or three persons for three or less days on site "addressing" a broad scope of ES&H functions, as well as corrective actions from previous appraisals. There was little evidence of field observation in these appraisals. When OR personnel did conduct field inspections, they identified numerous and significant performance problems. OR also performed detailed investigations of major UF_6 releases or other accidents. Although the Plant appeared to be responsive to the concerns and recommendations raised by OR, root causes and programmatic issues were rarely identified and addressed; the adverse conditions and performance reoccurred, or remained uncorrected in other Plant areas. In the 1980s, OR ES&H oversight became more rigorous and proactive, especially after the Tiger Team assessment in 1989 identified significant programmatic deficiencies and unsafe conditions and performance in the Plant. The AEC and its successors also investigated worker allegations of unsafe conditions and practices, but with inconsistent rigor and effectiveness. A 1980 review by the General Accounting Office sharply criticized DOE oversight of ES&H at the gaseous diffusion plants.

Goodyear Atomic Corporation management oversight of ES&H was reactive and often ineffective, as reflected in continuing ES&H problems through the years. The Plant responded well when Federal and state regulators raised major concerns or when new regulations were issued, implementing corrective actions and developing new programs and controls. However, Plant management often failed to ensure that ES&H staff recommendations were executed, or that ES&H requirements were implemented and enforced by first-line supervision.

Since its inception in 1954, OCAW took an aggressive approach to protect and improve employee welfare. This aggressiveness has resulted in strained relations between management and labor over the years and numerous strikes have occurred, four lasting longer than three months and two lasting well over six months. These strikes presented administrative and operational challenges to the Plant to maintain continuous production of enriched uranium. OCAW union members had filed an estimated 17,000 grievances by 1993, many addressing ES&H concerns. This process

brought attention to adverse conditions and resulted in safer and healthier working conditions and work practices.

Relations between the United Plant Guard Workers of America (UPGWA) union and Plant management were much less confrontational. Although protective forces have been an integral part of Plant activities due to security considerations, the ES&H protection provided to production workers (such as respirators and shoe covers) were not always considered or provided to security personnel when they worked in close proximity to hazardous operations or were stationed, ate lunch, and took breaks in contaminated areas. In addition, in the late 1980s and early 1990s, protective forces performed extensive training drills in radioactively contaminated buildings without appropriate protective clothing or monitoring. Hazard communications and ES&H training have not always been provided on a timely and consistent basis for protective force workers.

Conclusions

Historical operations and practices were significantly influenced by various external conditions related to local wages, industry practices, and world political conditions. With some exceptions, documented exposures to radioactivity were monitored and did not exceed the standards of the time. Due to weaknesses in monitoring programs, such as the lack of extremity monitoring, exposure limits may have unknowingly been exceeded. In addition, communication of hazards, the rationale for and use of protective measures, accurate information about radiation exposure, and the enforcement of protective equipment use were inadequate. Further, workers were exposed to various chemical hazards for which adverse health effects had not yet been identified. Environmental practices prior to Federal and state legislation in the 1970s and 1980s resulted in many adverse impacts to the environment, although essentially all on Federal property. AEC/ERDA/DOE and contractor management failed to proactively identify ES&H vulnerabilities, clearly communicate high expectations for ES&H performance, and implement consistent, effective corrective actions to known problems. Management also failed to ensure that hazard controls were implemented by supervisors and workers, resulting in additional and higher exposures to personnel and continuing unnecessary radioactive contamination.